

Research on the “Precision Teaching” and “Process Evaluation” System for the Advanced Mathematics I Basic Course for Engineering Students under the Background of Enrollment Expansion

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Abstract:

The paper investigates the construction of a quality assurance system for large-class higher mathematics teaching, centered on “data-driven” approaches and guided by the “precision teaching” philosophy. The system is designed to establish a closed loop covering “monitoring-diagnosis-intervention” within the context of enrollment expansion. The proposed system is then validated through practical implementation.

Keywords:

Precision Teaching, Process Evaluation, Differentiated Instruction

1. Introduction

Starting from the 2025 cohort, the Sino-European Institute of Aviation Engineering at Civil Aviation University of China will see a one-third increase in new student enrollment, while the faculty size remains unchanged. Against this backdrop, this paper takes the Advanced Mathematics I course as a practical platform, aiming to develop an effective quality assurance system that integrates “precision teaching” [3] and “process evaluation.” The overarching goal of this research is to explore viable pathways to maintain or even enhance teaching quality in the context of larger class sizes through systematic pedagogical reform [1]. Specifically, it will design and implement data-driven, differentiated instruction strategies to achieve precise diagnosis of individual student learning and targeted interventions. Concurrently, it will establish a diversified process evaluation mechanism that runs through the pre-class, in-class, and post-class phases to provide real-time feedback and optimize the teaching process. The ultimate aim is to develop a replicable and scalable teaching practice model, providing a theoretical foundation and practical example for similar foundational courses to cope with enrollment expansion, thereby ensuring that “quality is not compromised by increased quantity.”

2. Precision Monitoring: Construct a Comprehensive, Multi-dimensional Data Collection System for Tracking Student Learning Status Throughout the Entire Process

Classroom monitoring is not only a key link in assessing teaching quality but also an important component of the course evaluation system. Scientific and effective monitoring methods can stimulate students' learning motivation, thereby significantly enhancing classroom teaching outcomes. In response to the new challenges brought by the expansion of course scale, this course has timely adjusted its monitoring strategies, increasing the frequency of monitoring while focusing on improving its effectiveness and relevance [2].

Pre-course Learning Situation Survey: At the beginning of the semester, an online questionnaire focusing on bridging points between high school and university knowledge—such as the fundamentals of logical proof, complex numbers, and L'Hôpital's rule—will be administered. This aims to quantitatively analyze the differences in knowledge reserves among students from various educational backgrounds, providing empirical evidence for adjusting the teaching starting point and pace.

In-class Process Monitoring: As a key focus of this research, we will utilize an online platform (Xuexitong) to embed in-class knowledge quizzes—one quiz per lesson—supplemented by interactive activities such as discussions and Q&A sessions. This enables real-time collection of data on students' classroom comprehension and provides immediate feedback on teaching effectiveness. During the semester from September 2025 to January 2026, despite a one-third increase in the number of 2025 cohort students at the Sino-European Institute, the Advanced Mathematics I course has essentially achieved the goal of “one quiz per lesson.” The screenshot below shows examples of the implemented in-class tests.

Test 14: Neighborhood and Absolute Value Class D 2025, Class C 2025, Class B 2025, Class A 2025	0 Pending 22 Unsubmitted	Generate Image
Test 13: Interval Class D 2025, Class C 2025, Class B 2025, Class A 2025	0 Pending 159 Submitted	Generate Image
Test 12: Expansion of Real Number Set Exam Time: 2025-11-27 11:44 to 2025-11-30 14:30	0 Pending 10 Unsubmitted	Generate Image
Test 11: Definition of Supremum and Infimum Class D 2025, Class C 2025, Class B 2025, Class A 2025 Exam Time: 2025-11-10 11:30 to 2025-11-11 11:31	0 Pending 16 Unsubmitted	Generate Image

Figure 1. Screenshots of In-Class Quizzes (Partially Shown).

Feedback from the actual teaching of the 2025 cohort at the Sino-European Institute indicates that the “one quiz per lesson” teaching assistance strategy has proven effective for large-class instruction. It indeed helps students review in a timely manner, check and master the fundamental knowledge points covered in class, and plays a significant auxiliary role in enhancing the quality of classroom teaching. The screenshot below shows the test results for the content on the supremum.

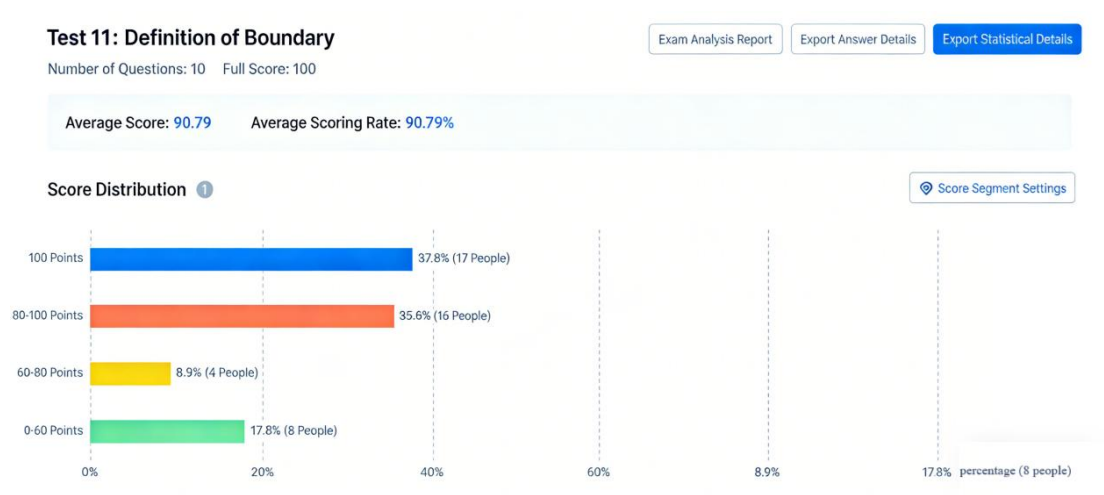


Figure 2. Test Results on the Concept of Supremum.

The results show that, whether for the challenging definition of supremum and infimum or the easily confusable concepts of supremum versus maximum/minimum, students deepened their understanding of the knowledge points and consolidated their foundational classroom knowledge with the aid of the quizzes.

Summative Assessment Evaluation: Conduct a comprehensive analysis of chapter assignments, process-oriented exams, and final exam scores to holistically assess students' ultimate mastery of each knowledge module, thereby forming a complete academic record for each student.

3. Precision Diagnosis: Establish a Mechanism for Identifying Common and Individual Problems Based on Data Mining

In teaching practice, it is crucial to make timely and accurate diagnoses based on teaching feedback. This process requires teachers not only to summarize common problems in students' mastery of knowledge points systematically, but also to pay sufficient attention to and grasp individual students' unique difficulties, thereby achieving comprehensive teaching support that addresses both the class as a whole and each learner individually.

Diagnosis of Common Problems: Leverage the data analysis functions of the teaching platform to perform cluster analysis on assignment and test data. This will quickly pinpoint common error hotspots within the class concerning core chapters such as “Complex Number Calculations,” “Supremum/Infimum Proofs,” and “Applications of Derivatives,” [4] thereby precisely identifying weak links in teaching.

Individual Learning Profiles: Based on continuously collected data, generate dynamic radar charts of learning status for each student, visually representing their proficiency across various knowledge dimensions. The system will automatically issue early warnings for students whose performance consistently falls below a set threshold, enabling precise identification and targeting ranging from the group level down to the individual. For example, the figure below illustrates one student's grasp of common functions. The chart indicates that the student's understanding of the graphs of the arctangent function and the inverse hyperbolic tangent function is not yet solid, suggesting they should review and reinforce these relevant concepts in a timely manner.

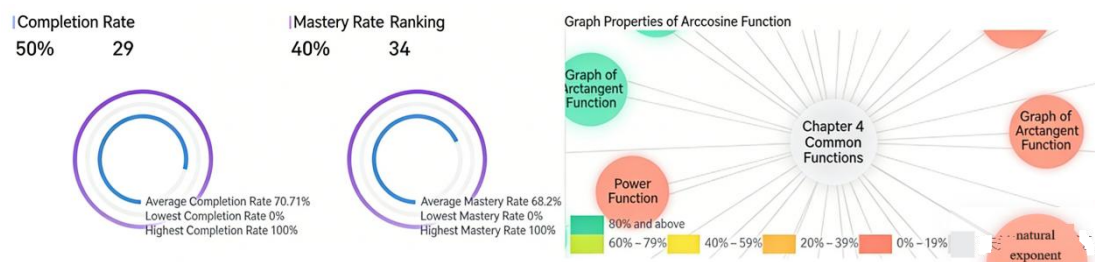


Figure 3. A Student's Mastery of the Elementary Functions Chapter.

4. Precision Intervention: Implementing Differentiated, Intelligent, and Targeted Teaching Strategies

Intervention in the teaching process serves as a vital auxiliary means to ensure instructional effectiveness. By rationally allocating teaching resources, strengthening classroom management, and improving after-class guidance and tutoring, the pertinence and practical efficacy of teaching can be effectively enhanced, thereby providing strong support for the achievement of teaching objectives [5].

Tiered and Intelligent Resource Recommendation: Construct a three-tiered digital resource library categorized as “Basic-Consolidation-Advanced.” Based on individual learning profiles, the system will automatically and personally push differentiated exercise packages and remedial micro-lectures to students, achieving adaptive learning support tailored to each student's needs (“thousands of faces with thousands of approaches”).

Facilitated Formation of Study Groups: Based on students' learning status, organize offline study groups, assign thematic discussion tasks, and implement “Peer Instruction” to stimulate collaborative learning motivation among students. It is anticipated that these study groups will continue to play a role in future mathematics learning and other subjects.

Prioritized and Precise Tutoring: Establish a Q&A mechanism prioritizing “online first, offline supplementary.” Teachers will prioritize one-on-one online tutoring for key students identified by the system's early warning list. Offline centralized Q&A sessions will be organized twice a week to maximize the use of faculty resources for solving individual problems, ensuring the effectiveness of interventions.

5. Conclusions

This paper primarily discusses coping strategies for addressing the challenge of increased class sizes in the context of international cooperative education. Facing the challenge of a one-third increase in enrollment without additional faculty, the teaching team fully utilized the online platform, combining offline instruction with online testing to comprehensively grasp the learning situation, adjust teaching plans in a timely manner, and enhance classroom teaching quality and effectiveness. This research provides insights for current large-class higher mathematics instruction.

Conflicts of Interest

The author declares that there is no conflict of interest regarding the publication of this article.

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